Title: Where Do Blue Widgets Grow?

Brief Overview:

Working in groups, students will randomly sample the soil around the school grounds. They will collect and organize data on the pH of the soil to determine if the school would be a suitable place to grow a new plant species the "blue widget." They will plan and execute a statistical experiment which will result in a decision being made based on statistical outcomes. Students will be required to support their thinking throughout the process.

Links to Standards:

- **Mathematics as Problem Solving**
  The students will demonstrate their ability to collect, organize, and infer about data.

- **Mathematics as Communication**
  Students will be able to communicate an appropriate sampling plan, a summary of their procedures, and a recommendation based on their findings.

- **Mathematics as Reasoning**
  Students will be able to decide on the appropriate statistic to test the hypothesis based on factors that appear in the problem. Students will be able to make a decision to accept or reject the vendor's proposal.

- **Mathematical Connections**
  Students will connect chemistry, business, agriculture, technology, and statistics in a real-world setting.

- **Algebra**
  Students will use formulas to determine their statistics.

- **Statistics**
  Students will plan and carry out a statistical experiment from planning through data collection and decision making.

- **Cooperation**
  Student will work in pairs, with each student responsible for designated tasks. Both will participate in organizing and analyzing data.

Links to Maryland High School Mathematics Core Learning Goals:

- **3.1:** The student will collect, organize, analyze, and present data.

Grade/Level:

Grades 11-12, Elementary Statistics

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- computing summary statistics
- formulating a hypothesis test and using statistics to test the difference between means
- using a CBL and TI-82

Objectives:

Students will:

- analyze a problem situation that can be answered by using a statistical experiment to make inferences about data.
- use the CBL to aid in data collection.
- use the TI-82 to analyze data.
- will communicate in writing a recommendation for action based on their statistical analysis.

Materials/Resources/Printed Materials:

- TI-82, CBL, and pH sensor (for each group)
- 100 square scale grid of target area
- Lab data sheet
- Lab report form
- Distilled water bottles for each group
- 10 vials with labels and stoppers
- 1 spoon
- Trundle wheel and chalk or tape measure and string (to mark off $1000m^2$ area)

Development/Procedures:

Prior to class the teacher should mark off a $1000m^2$ section of land into a 10x10 square grid, numbered from 1 to 100 to correspond to the grid. Also, copy the gridded (and numbered) sheet representing the area.

The teacher should familiarize the class with various calculator functions using several of the probes and small data sets. They should also review sampling plans and how to implement them as well as characteristics of z and t tests and associated formulas. The students will receive a standardized lab data/report sheet, a TI-82, CBL, and pH probe. The teacher should preview the lab sheet with the students.

The class will be divided into partners. Each partner pair will be asked to reach a conclusion based on the scenario provided in the lab sheets.

In the field, students will put one sample in a vial and label the vial. In the lab, these vials will be tested for pH value.

Performance Assessment:

This lesson is designed so that approximately one-third of the grade is based on the preliminary lab sheet. After reviewing their answers, the students can then adjust their plan. The remainder of the grade will be based on accuracy of the data, correctness of their conclusions, and the richness of their written recommendation.

Scoring Rubric

4 Includes accurate $\overline{X}$ and comparison to μ; some statement of why they say it is significantly different (using t values); state decision to reject or accept offer; and support decision.

3 Correct decision to accept or reject offer; minor calculation errors; and sound reasoning, but not thorough communication of that reasoning.

2 Shows some understanding of methods of calculation, but little interpretation; must have accurate $\overline{X}$; some calculation errors acceptable; and some reasoning, though not necessarily thorough or solid.

1 Show little understanding; must have accurate $\overline{X}$; errors in calculation of s and t; and no support.

0 Shows no understanding and/or no work at all.

Extension/Follow Up:

The students could be shown the other types of CBL probes and be asked to design a similar scenario to test.

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Scenario

Dear Mr. Principal,

It has come to our attention that you have approximately 1000 square meters of farmland unplanted. We would like to propose the planting of a new variety of ornamental shrub, the Blue Widget. We would make these available to you at a minimal cost ($500) which could easily be recouped and profit made by sales after one year. The only requirement is that the pH of the ground be no more that 4.5. The blue widget will not tolerate a less acid soil. Please let me know your decision as soon as possible.

Sincerely,
Allan Descaper

Mr. Principal has asked us to evaluate whether or not the blue widgets can be successfully grown on the available land given its pH. For purposes of this activity, assume a sample size of 10.

Directions: Answer the following questions to design your statistical experiment.

1. What is the basic question that must be answered?

2. What statistic would be most appropriate to use to make this decision z or t. Why?

3. What alpha level will you use and why?

4. What are the null and alternative hypotheses?

5. Is this a one-tailed or two-tailed test? Explain your answer.

6. What is the critical value we need to reject the null? Write a decision rule.

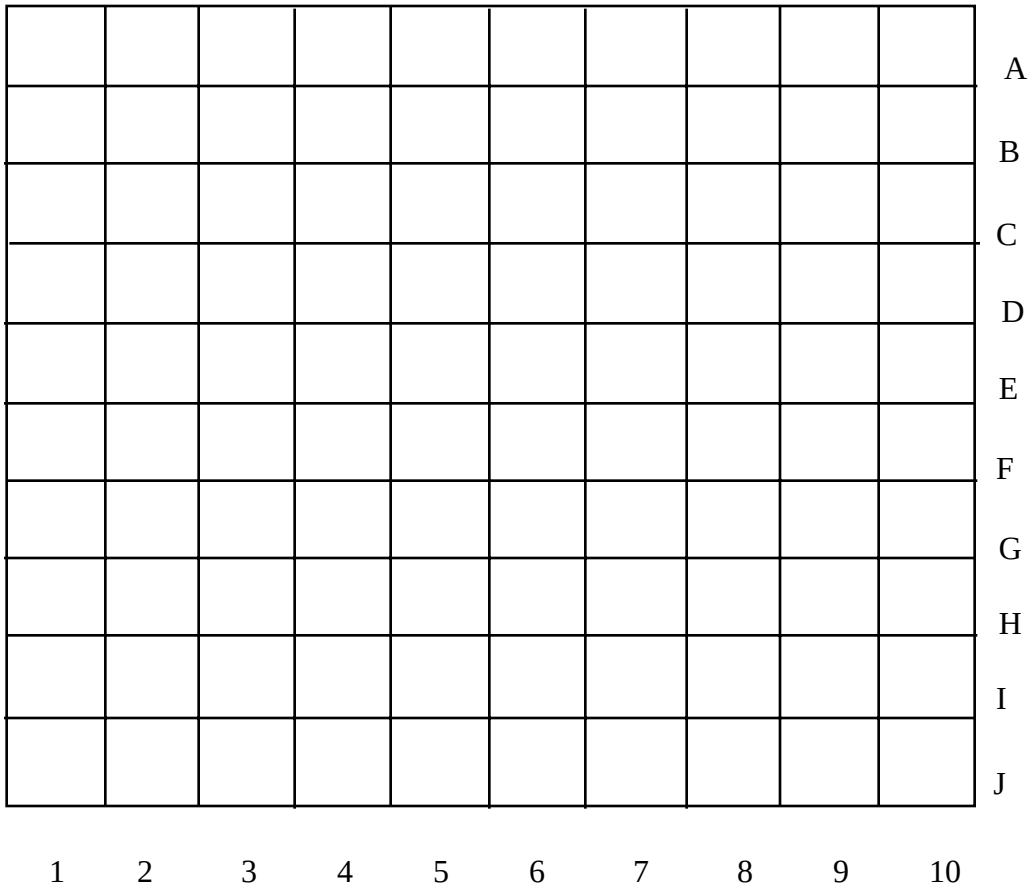
7. Given your alpha level, discuss the probability of a Type I and Type II error in this problem. (Not just numbers but the costs or gains)

8. What is the value of μ in this problem?

9. How will you find $\underline{X}$?

10. What other statistic will you need?

11. Write your sampling plan in detail. Justify it.



Data Collection

Directions: Use your sampling plan to choose 10 of the squares above. In the field, find the corresponding square. Put one sample of soil in each vial. Label the vial. In the lab, add distilled water to soil sample (1:1). Test sample using pH probe and CHEM program on the CBL. (Note: After set-up probe, choose "use stored")

Samples

Square ID	pH Value	Square ID	pH Value
1		6	
2		7	
3		8	
4		9	
5		10	

$\underline{X}$ = _____ S = _____

Your Report

Results:

Decision:

Interpretation:

Write a brief letter to Mr. Principal with your recommendation (include your reasons, support your recommendation, explain the statistics involved).